

Microfluidic System for CO₂ Reduction to Hydrocarbons in Microgravity, Phase I

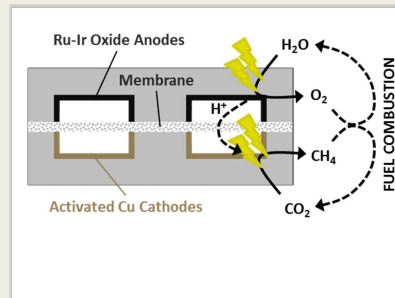
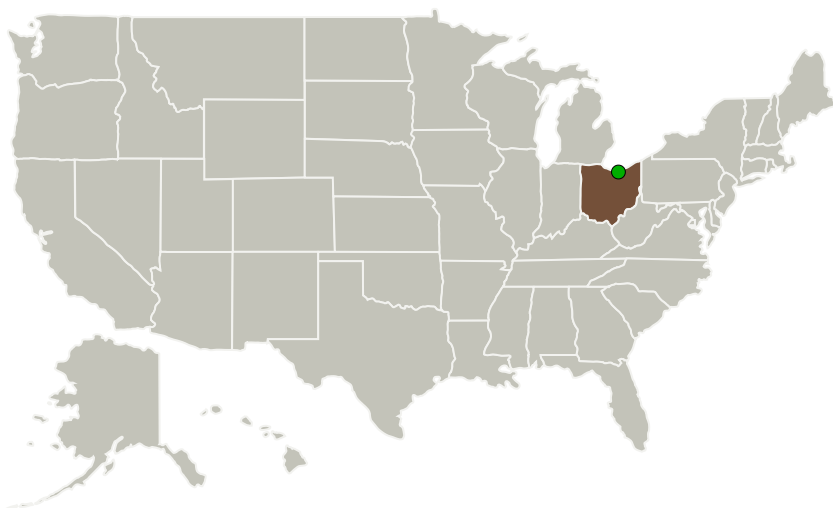
Completed Technology Project (2014 - 2014)



Project Introduction

In the combined Phase I and Phase II programs Faraday and our MIT collaborators will demonstrate the feasibility of low-cost fabrication of high-efficiency, microchannel-plate reactors for the electrocatalytic reduction of CO₂ to CH₄. The proposed concept is founded on FARADAYIC® Through-Mask Etching of metallic (e.g., stainless steel and titanium) substrates to form suitable microchannel electrodes, and on pulse-reverse FARADAYIC® Electrodeposition of copper for uniform coating of the cathode surfaces. The electrocatalytic efficiency of the copper layer will be enhanced through the use of a literature-reported oxide-reduction process. Inclusion of a suitably large density of channels should result in substantial active area in a compact form factor, while entirely avoiding the complications of packed-bed type reactors. Faraday plans to focus development toward the ultimate use of room-temperature ionic liquids (ILs), as they afford such advantages as negligible evaporative loss, generally high CO₂ solubility and low CH₄ solubility, and a broad potential window of electrochemical inertness. The particular challenge of gas-liquid separations in microgravity, where buoyant effects cannot be exploited, will be addressed through a novel centripetal application of an established spiral-channel microfluidic concept. The envisioned system described in this proposal consists of three distinct unit operations: (1) an absorber which "getters" gaseous CO₂ from the atmosphere using a wet room temperature IL-based electrolyte, (2) a microfluidic electroreactor which efficiently converts the CO₂ to CH₄ with oxygen being generated as useful by-product, and (3) a spiral-channel gas-liquid separator to remove the CH₄ and O₂ from the IL stream which is recycled to the absorber.

Primary U.S. Work Locations and Key Partners



Microfluidic System for CO₂ Reduction to Hydrocarbons in Microgravity Project Image

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Organizations Performing Work	Role	Type	Location
Faraday Technology, Inc	Lead Organization	Industry	Clayton, Ohio
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations

Ohio

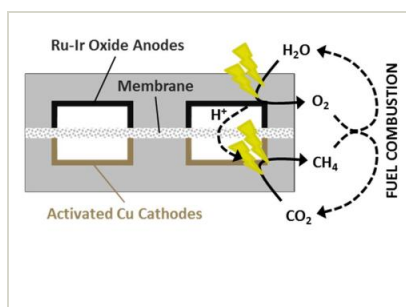
Project Transitions

**June 2014:** Project Start**December 2014:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/137679>)

Images



Project Image

Microfluidic System for CO₂ Reduction to Hydrocarbons in Microgravity Project Image (<https://techport.nasa.gov/image/132888>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Faraday Technology, Inc

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

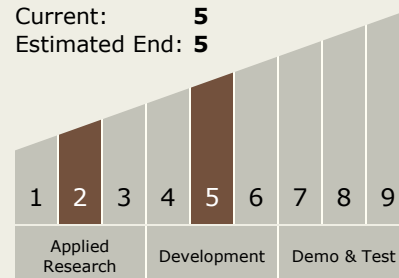
Carlos Torrez

Principal Investigator:

Brian Skinn

Technology Maturity (TRL)

Start: 2
Current: 5
Estimated End: 5



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Technology Areas

Primary:

- TX07 Exploration Destination Systems
 - └ TX07.1 In-Situ Resource Utilization
 - └ TX07.1.3 Resource Processing for Production of Mission Consumables

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System